



(51) International Patent Classification:

H05K 1/05 (2006.01) F21V 15/01 (2006.01)
H05K 1/02 (2006.01) F21V 23/06 (2006.01)

(21) International Application Number:

PCT/EP2021/071594

(22) International Filing Date:

02 August 2021 (02.08.2021)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

20190103.0 07 August 2020 (07.08.2020) EP
2020713.0 30 December 2020 (30.12.2020) GB

(71) Applicants: ZUMTOBEL LIGHTING GMBH [AT/AT];
Schweizer Str. 30, 6850 Dornbirn (AT). TRIDONIC
GMBH & CO KG [AT/AT]; Färbergasse 15, 6851 Dorn-
birn (AT).

(72) Inventors: KUBAN, Marek; Wiesenrain, 6850 Dorn-
birn (AT). LORENZ, Stefan; Hubertusstraße 13, 90592
Schwarzenbruck (DE). MAYRHOFER, Markus; Schmelz-
hütterstraße 33a, 6850 Dornbirn (AT). PÖHS, Mario;
Schlossgasse 11a, 6850 Dornbirn (AT). ZENGERLE,
Thomas; Langener Straße 13, 6921 Kennelbach (AT).

KOCH, Patrik Yves; Friedhofstraße 3, 88085 Langenar-
gen (DE). LOCHMANN, Frank; Kapellenweg 1/1, 88147
Achberg (DE). SCHNELL, Patrick; Belchenstr. 9, 88097
Eriskirch (DE). SIMMA, Lukas; Dorf 28, 6914 Hohen-
weiler (AT). ZENGERLE, Thomas; Langener Straße 13,
6921 Kennelbach (AT).

(74) Agent: BARTH, Alexander et al.; ZumtobelGroup IP
Management, Höchsterstrasse 8, 6850 Dornbirn (AT).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN,
KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD,
ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO,
NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW,
SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

(54) Title: LUMINAIRE AND HOUSING FOR SUCH A LUMINAIRE WITH INTEGRATED LINE FOR TRANSMITTING SIG-
NALS

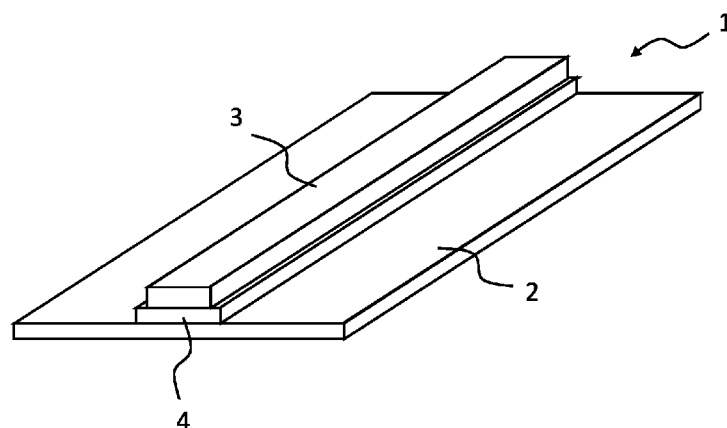


Fig. 1

(57) Abstract: A housing for a luminaire or an operating device for the luminaire, wherein the housing is configured to accommodate at least one electronic component and/ or a light source, and comprising a conductive housing component (2). The housing includes at least one line (1, 1', 1'', 1''', 1''''') for transmitting electric high frequency signals or for transmitting and/ or receiving radio waves. The transmission line is formed by arranging a dielectric layer (4, 4a, 4b, 9) and a conductor (3, 3..3c, 7) on the housing component (2) such that the conductive housing component (2) serves as a reference plane, and the conductive housing component (2) and the conductor (3, 3..3c, 7) sandwich the dielectric layer (4, 4a, 4b, 9).



EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

Luminaire and housing for such a luminaire with integrated line for transmitting signals

Description

5

The invention regards a housing with an integrated line for enabling a wired or wireless signalling and a luminaire with such a housing.

Information processing becomes more and more important in nearly any technical area.

10

Processing performance increased over the last decades to such an extent that nearly every technical development makes use of analysis of information received, for example, from sensors connected to a device. However, it is not reasonable to provide every device, or rather its processor, with dedicated sensor signals. Thus, systems have been developed where a plurality of information processing devices are connected via a network. Such a network enables the devices to communicate with each other thereby reducing the need for redundant sensors, for example. Further, controls of devices may interact with each other by exchanging information so that controlling the devices can be adapted for commonly achieving a specific task.

15

Unfortunately, establishing such networks or, to be more general, communication systems, usually causes additional costs, needs space for integration and apparatuses and finally still offers limited performance. A higher interaction of devices of distributed systems, for example in the building, is desired and consequently lighting systems have been identified as offering advantageous prerequisites for supporting cabling using the mechanical structure of luminaires. Using a lighting system for distributing and collecting information all over a building has the advantage that the lighting installation anyway provides a distributed grid.

20

25

Nevertheless, there are some drawbacks current lighting systems have. First, transmission of information or data is usually performed by using extra cabling that is mounted in, for example, a luminaire and which is used to transmit signals from one electronic component to the other.

30

Point to point connections like contemporary Ethernet, or optical cables obviously have the disadvantage of an increasing amount of extra cabling in case of a plurality of components communicating with each other. It is desirable to reduce the costs and space needed for such extra cabling while at the same time to improve flexibility of positioning involved components. Bus systems have been developed such as the DALI system which could at least reduce the amount of additional cables needed.

35

Other solutions use existing cabling. One example is power line communication. Of course, the additional cabling can be avoided or at least reduced. But powerline communication is impeded

by high frequency losses and consequently limits in transmission speed over long distances are unavoidable.

Having in mind all these drawbacks of solutions known from the state in the art it is evident that
5 there is a need for improvement for enabling communication of electronic components.

The goal is achieved with the inventive housing for a luminaire or an operating device for the luminaire and the respective luminaire according to the independent claims. With the present invention, the versatile line for transmitting data signals with high speed and bandwidth or for
10 transmitting and/or receiving radio waves is integrated into a luminaire using its conductive housing component. Many luminaires have metallic housing components, which can serve as the conductive housing component according to the invention. Luminaires are distributed over buildings and even outside areas and thus offer an advantageous structure for transmitting information signals. This is particularly true in case of trunking lighting systems or light tracks
15 (light rails) that allow transmitting signals over a long distance and in many places without leaving its own structure. Trunking lighting systems typically may extend up to lengths of 100 m or the like.

The luminaire according to the invention comprises a housing in which at least one electronic component and/or a light source are accommodated. Transmission of signals to or from the
20 electronic component is performed using a line, which is, according to the invention, formed by arranging a dielectric layer and a conductor on the conductive housing component. As the conductive housing component, for example, a metallic housing component, supports the dielectric layer and the conductor such that the line suitable for transmitting high frequency electric signals is established. This line can then be used in order to transmit signals to or from
25 the electronic component contacting the line to receive signals from or transmit signals to the line or transmit and/or receive radio signals (radio waves). The conductive housing component serves as a reference plane (sometimes also ground plane) for the line.

As can be easily understood from above explanations of the main structure of the inventive
30 housing for a luminaire or an operating device and the respective luminaire itself, a high degree of integration is achieved by using the conductive characteristic of the housing component for establishing a line for high frequency signal transmission. In case of a wired signalling, the need for mounting additional cables for enabling signal transmission within the luminaire or even accommodating wireless communication is thus not needed anymore. This significantly reduces
35 costs by avoiding additional work in a manufacturing process. The line attached to the housing component furthermore allows to be contacted by the electric components accommodated in the housing of the luminaire using the line for transmission or reception at arbitrary positions.

Having in mind that often designers require a high degree of flexibility to arrange components inside the luminaire, the variety of luminaires that can be designed using this structure for data transmission lines is increased. Particularly, when a plurality of electronic components communicating with each other must be arranged in the luminaire, distribution of the components can be achieved without an adaptation of, for example, existing cabling. Further, no standardized connectors have to be used as the surface of the line, namely the conductor, can be directly contacted at its surface. In case of wireless signalling, an antenna is formed by the conductor and the dielectric layer arranged on the conductive housing component. In this way, the performance of the antenna can be increased, wherein the antenna can be placed in an optimum position inside or outside the housing.

Further advantageous aspects and details are defined in the dependent claims.

For further cost reduction, it is preferred to use an existing or usually needed coating of the conductive housing component as dielectric layer. Such a coating may be a powder coating applied to the conductive material of the housing component or a paint, foil, or a suitable anodization, for example. Any kind of coating that can be applied to the conductive material of the conductive housing component can be used. The thickness of such a coating shall be adjusted in order to have reasonable values based on the dielectric constant of the used material. Further, in order to achieve characteristics comparable to a microstrip created on a printed circuit board, application of the coating must fulfil requirements regarding variation of thickness in the direction in which the line is formed. However, it is not necessary that constant thickness is achieved all over the conductive housing component, because areas distant from the line may show an increase or reduction of thickness, which does not badly affect the characteristics of the line. For example, a reduced layer thickness at edges of a surface where the line is formed, may not disturb signal transmission. So positioning the line in an area of the conductive housing component where application of a coating can be achieved with sufficiently constant thickness supports generating a transmission line having the desired electromagnetic or electrodynamic characteristics.

Further, it is to be noted that such a coating does not necessarily need to constitute the entire dielectric layer between the conductor and the conductive material of the housing component. For example, in case that the conductive housing component is coated in the manufacturing process it is still possible to add a further dielectric material on the surface of the coating. In such a case, the dielectric layer consists of two sub layers, the first being formed by the coating of the conductive housing and the second by an additional dielectric material. Preferably, the additional material is an adhesive tape stuck to the housing component. Of course, it is also

possible to use only such an adhesive tape as the dielectric layer. Using adhesive tapes has the advantage that the application of such a tape is very easy and tapes are available in various different materials and with different dimensions so that the dielectric constant can be easily selected appropriately. The manufacturing process is very easy and flexible, because tapes can
5 be applied on almost every side or surface of the conductive housing component.

Alternatively, an adhesive film may be applied directly on the metal tape, without a separate dielectric carrier. This embodiment may use the adhesive coating of the metal band as dielectric.

10 Furthermore, adhesive tapes can be produced already carrying the conductor. An adhesive tape consisting of the adhesive and a dielectric support structure on top of which the conductor is already mounted, will result in the desired line on the conductive housing component in only one manufacturing step which is the application of the adhesive tape on a suitable surface of the housing. Adhesive tapes already carrying a conductor are available on the market. Such tapes
15 can be cut to the desired lengths thereby enabling an adaptation to different housings, easily.

Alternatively, the conductor can be applied in a separate manufacturing process and using a different technique, after the dielectric layer has already been attached or applied on the respective surface of the conductive housing component. The conductor can be applied, for
20 example by chemical or physical vapor deposition of a metal (sputtering), drawing a line of conductive ink, or attaching a metal foil, in an independent application step from sticking the adhesive tape mentioned above. All these techniques allow an easy control of the desired dimensions of the conductor and dielectric layer, so that an adaptation of the electric characteristics of the line can be made according to the specific application.

25 Alternatively or in addition, the conductor can be completely enclosed by dielectric layers, wherein the dielectric layer and at least another dielectric layer sandwich the conductor. The dielectric layers can be realized using (self-adhesive) films/ foils, wherein the films enclosing the conductor form an adhesive tape.

30 It is particularly preferred that the housing component comprises a flat section to which the dielectric layer and the conductor are attached so as to establish a transmission line and/or an antenna, in particular a microstrip patch antenna. A transmission line such as a microstrip has well-known electrical (e.g. electromagnetic and electrodynamic) characteristics and has proven
35 to be capable of satisfying the highest demands regarding signal transmission with low RF losses. Further, the dimensions needed for the dielectric layer and the conductor are very small compared to typical dimensions of housing components of a luminaire. As a consequence,

creating a transmission line by using the conductive housing component as a reference plane achieves a high degree of integration of a communication line in the luminaire structure without the need of additional space.

5 The antenna can be a monopole antenna or a dipole antenna.

Alternatively or in addition, the transmission line can be a connection line of the antenna.

Preferably, the transmission line can form a coplanar waveguide, in which the conductor
10 together with a pair of return conductors sandwiching the conductor are arranged on the same side of the dielectric layer and the conductive housing component serves a third return conductor.

Further, the transmission line may be enhanced by adding at least one further line that could be
15 attached on top of the first line for a stacked arrangement, be twisted with the first line or arranged side-by-side with the first line. Using such a second line would enable to transmit differential signals.

A further improvement of the characteristics can be achieved with a projection that is formed on
20 the conductive housing component projecting from the same surface to which the dielectric layer and the conductor are attached. Different shapes of the ground plane can easily be provided during the manufacturing process of the housing component. Typical manufacturing processes of the housing of luminaires are extrusion, deep drawing of a metal sheet or any other kind of sheet metal forming. It is specifically preferred if the protrusion simultaneously serves a
25 structural purpose, for example enhancing rigidity of the housing component. Thus, the protrusion may be formed as a corrugation or rib.

Instead of forming a flat transmission line like a microstrip line using a flat or only slightly curved surface of the conductive housing component, it is also possible that the transmission
30 line is formed as a 3D-line with a portion of the housing surrounding the conductor at least partially in cross section. The resulting 3D-line approximates the geometry of a coaxial a coaxial transmission line integrally formed using the conductive housing component as an outer shield and reference of the coaxial cable. Such a structure may preferably be established in an inner corner of the housing, when the housing is seen in cross section.

35 Preferably, at least one connector is provided at or in the housing contacting the line and enabling another line and/or an electronic component of the luminaire to connect to the line for feeding the line with a signal and/or receiving a signal from the line. The connector can make use for example known techniques like linear microstrip dividers, circular power dividers or

other known forms of power splitters. Further, a direct contact with the open surface of the conductor, which is the surface side facing away from the ground plane, can be made using a spring loaded metal contact (a so-called pogo pin), a conductive polymeric contact or a metal spring, pressing on the open surface of the conductor. Alternatively, capacitive or inductive
5 coupling can be used.

Specifically, when the element making the mechanical contact or establishing the contactless coupling could be directly included in the electronic components to be connected to the line. Then, it is only necessary to position the electronic component in the housing such that the
10 contacting or coupling elements is positioned at the line to make a direct mechanical contact or enable conductive or capacitive coupling.

According to another aspect, the housing has a modular structure comprising a plurality of housing components commonly forming a ground plane of the line established by commonly
15 arranging a dielectric layer and a conductor on the housing components. In such a case it is possible to combine a plurality of different modules (conductive housing components) first, and then attach the dielectric layer and conductor on the combined and electrically connected modules. This allows to mount the housing with its final shape for example on the ceiling of a building and then attach the dielectric layer and the conductor to establish the line finally used
20 for communication between a plurality of different electronic components. Specifically, if the transmission line is formed by using an adhesive tape as a dielectric layer carrying the conductor already, the line can be created when mounting the lighting system. Not only that no connector between dielectric layers sections and conductor sections of different modules is necessary but also an attachment of the adhesive tape for generating the line is only necessary when the
25 respective luminaire needs a line for communication or signalling.

Alternatively, a modular housing comprises a plurality of housing components each forming a reference plane of respective line sections wherein the line sections of the plurality of housing components are connected with each other to realize the entire line. In such a case, no
30 application of the dielectric layer and the conductor is needed at the construction site, where usually dust is a problem so that attaching an adhesive tape may cause additional effort to clean and prepare the surface on the conductive housing component.

Finally, ground of the electronic component of the luminaire advantageously is connected to the
35 metallic housing component. This results in involved electric components and the line having the same electric potential as ground. Adjustments of impedance can easily be achieved resulting in improved reflection characteristics when transmitting signals over the line. As the

reference plane of the line is part of the housing of the luminaire, it is easy to connect electronic components of the luminaire with the metallic housing component as well so that no additional ground connector or terminal for connection of the line is necessary.

The structure of the housing including a line according to the invention in a plurality of different
5 embodiments of such integrated lines transmitting microwave or radiofrequency signals in a luminaire will now be explained with reference to the attached drawings in which

- Figure 1 shows a general structure of a line according to the invention using a
conductive housing component as ground plane;
- 10 Figure 2 shows a cross-section of the first embodiment of a line formed as a microstrip transmission line;
- Figure 3 shows a cross-section of a second embodiment adapted for transmitting
15 differential signals;
- Figure 4 shows a cross-section of the third embodiment adapted for transmitting a
differential signal with stacked transmission lines, or transmitting with a
second reference on top;
- 20 Figure 5 shows a cross-section of a fourth embodiment using a multilayer dielectric between the conductor and the conductive housing component;
- Figure 6 shows a cross-section of a sixth embodiment with projections adjacent to a
25 signal conductor of the transmission line for improvement of electrical characteristics of the transmission line;
- Figure 7 illustrates the various positions at which the line can be attached to a
housing of the luminaire and a further embodiment of a line formed as a 3D
30 transmission line;
- Figure 8 illustrates a technique and a contacting element for contacting a
transmission line using a spring loaded metal pin;
- 35 Figure 9 illustrates a further contacting element using a metal spring for contacting a transmission line;
- Figure 10 shows an antenna attachable to the housing according to the invention; and

Figure 11 shows a cross-section of a seventh embodiment of a line formed as a coplanar waveguide.

The same features are denoted by the same reference signs throughout all figures.

5 The general structure of a line formed on a portion of a housing of a luminaire will now be explained with reference to figure 1. Figure 1 shows a perspective illustration of a line 1 as one preferred example of the line according to the invention. The line 1 is generated using a
10 conductive housing component 2 of a housing of a luminaire. Since the housing component can be any part of the conductive housing of the luminaire and for an easier understanding of the drawing, other components of the luminaire are not illustrated in the drawing.

The conductive housing component 2 may be, for example, a metallic body of luminaire, such as a light rail manufactured as extruded metal or deep drawn metal sheets. It is to be noted that the
15 particular way of manufacturing the housing component is not relevant for the invention as long as a reasonable shaped surface is generated and the housing component is made of conductive material. Further, the surface of the conductive housing component 2 visible in figure 1 may be an outside surface of the conductive housing component or a surface oriented towards the inside of the housing of the luminaire.

20 Using an outward oriented surface of the conductive housing component 2 has the advantage that the line may also be created after the conductive housing component has been mounted, for example, on a ceiling of the building. Of course, generating the line may also be performed on an inner surface of the conductive housing component 2. Examples for different positions on a housing of a luminaire will be explained in greater detail below with reference to figure 7.

25 The conductive housing component 2 has a flat surface on which a dielectric layer 4 is arranged. Application of the dielectric layer 4 may be achieved by sticking an adhesive tape to the surface of the conductive housing component 2. Other techniques may also be used as long as it can be ensured that the dimensions of the dielectric layer 4, particularly its thickness, can be controlled
30 with sufficient accuracy.

A conductor 3 is attached on top of the surface of the dielectric layer 4 being oriented away from the conductive housing component 2. The conductor 3 may be made from arbitrary conductive material, in a preferred embodiment copper is used as conducting material for the conductor 3.

35 The dielectric layer 4 and the conductor 3 may be applied in a single manufacturing step. For example, the conductor 3 is attached to an adhesive tape made from dielectric material and forming, after sticking the adhesive tape to the surface of the conductive housing component 2,

the dielectric layer 4. Alternatively, the dielectric layer 4 and the conductor 3 may be generated on the surface of the conductive housing component 2 in two successive manufacturing steps. It is particularly preferred that the dielectric layer 4 is made from a material that is simultaneously used for protecting the surface of the conductive housing component 2 or even for optical reasons. Often, such protective layers are formed on the outer surface of a housing component but also on the inner surface of the housing of the luminaire in order to cover the entire surface of the housing. Preferred techniques are powder coating, spray painting, or anodizing. These techniques allow controlling the thickness of the layer with sufficient precision in order to use it, having knowledge of the dielectric constant of the material used, as the dielectric layer 4 for a line having a structure as shown in figure 1.

In case that such a coating of the conductive housing component 2 is used as a dielectric layer 4, the coated housing is then used as a substrate for attaching the conductor 3. The conductor 3 can be attached to the coated conductive housing component 2 by sticking an adhesive metal foil as conductor 3 on top of the coating, drawing a line using conductive ink or using vapor deposition techniques for sputtering metal particles to generate the conductor 3. Specifically the latter technique allows to use masks for generating arbitrary shapes of the conductor 3, thereby not only generating a line for transmitting microwave or radiofrequency signals along the extension of the housing of the luminaire but also creating electronic components such as power dividers or the like.

Electrical characteristics of lines that may typically be used for communication within a luminaire may typically be achieved with dimensions of the dielectric layer 4 and the conductor 3 that can easily be realized, even on small housing components and limited flat or almost flat portions of the housing component. For example, an impedance of 75 ohms for the transmission line can be achieved by using a metal luminaire housing component 2 with a powder coating having a thickness of 100 μm and a conductor thickness of 35 μm . A width of 0.075 mm of the conductor 3 then leads to an overall impedance of 75 Ohms assuming the dielectric constant of the powder coating being 4. The dimensions given above as an example can be realized by applying a selected foil or applying a single strand of wire having a diameter of 0.1 mm resulting in an impedance of 62 Ohms. As mentioned above already, alternative techniques for applying the metallic conductor 3 are physical or chemical vapor deposition, laser scribing or sintering, which all can be used in order to apply a metallic conductor 3 having the desired dimensions.

A cross-section of the simple version of a transmission line 1 (microstrip 1) shown in the perspective illustration in figure 1 is shown in figure 2. It is to be noted that in all the described and illustrated embodiments, the dimensions of the different layers (conductive housing

component, dielectric layer and conductor) and, particularly the overall dimension of the conductive housing component 2 is not limiting. The skilled person will easily understand that the conductive housing component 2 may be any part of the housing that offers sufficient surface area to apply the dielectric layer 4 and the conductor 3. Although it is described to
5 generate a transmission line by sandwiching the dielectric layer 4 between the conductor 3 and the conductive housing component 2 by attaching the dielectric layer 4 and the conductor 3 to a flat portion of the conductive housing component 2, the surface does not need to be entirely flat. Even slightly curved surfaces may be used, although, application of the dielectric layer 4 and the conductor 3 may be a little bit more difficult. However, even application of the dielectric layer 4
10 and the conductor 3 on a curved surface of the conductive housing component 2 is considered to create a transmission line 1 in the sense of the present invention.

Often it is desired to transmit differential signals from one component to another for communication within a luminaire. Thus, the structure as shown in figure 1 and figure 2 may be
15 applied twice with defined and given distance between the 2 arrangements as it is shown in figure 3. The resulting transmission line 1' is then used for transmission of differential signals for communication between connected electronic components. The general structure of each individual transmission line attached to the same conductive housing component 2 is the same and, particularly, the dimensions of the individual and neighbouring transmission lines are the same as it can be seen in figure 3. The respective components are indicated with "a" and "b" in
20 the drawing. It is to be noted that it is also possible to use a common dielectric layer for both conductors. Such an arrangement is particularly useful when the coating of the metallic housing component 2 shall be used as the dielectric layer.

25 Even more than two lines or three may be arranged adjacent to each other. For example, a central line and two ground lines may be arranged adjacent to each other and running in parallel, in order to achieve an improved signal guidance.

Another alternative for creating a transmission line 1'' for transmitting differential signal is shown in figure 4. Again, two transmission lines are generated, the different components of
30 which are marked as "a" and "b". However, this time the transmission lines are stacked thus arranging a second dielectric 4b on top of the first conductor 3 a, followed by a second conductor 3b. It is apparent that due to the stacking the width of the successive layers stepwise decrease. Nevertheless, reasonable selection of the dielectric constants of the materials and also the further dimensions, namely the thicknesses of the layers allowed to adjust the overall
35 impedance as desired.

All embodiments that have been explained so far make use of a single dielectric layer 4, 4a, 4b. However, application of a dielectric material can also lead to a plurality of dielectric sub layers, for example, in case that an adhesive tape made of a dielectric material is attached to a coating of the conductive housing component 2, which is already present at the end of manufacturing
5 the respective housing part. Such an example is illustrated in cross-section in figure 5. The conductive housing component 2 is coated with a coating layer 5 to which the dielectric layer 4 is then attached followed by the conductor 3. The coating 5 and the dielectric layer 4 both builds sub-layers of the entire dielectric layer and have to be considered when designing the microstrip, in particular the thicknesses of the involved dielectric material sub-layers 4 and 5.

10 Further, while the width of the coating 5 is not limited by the structure of the transmission line, because the coating 5 is attached to the entire conductive housing component 2 first and independent from the layers attached finally, the attached dielectric sublayer 4 does not need to have the same extension in the width direction as the coating 5 constituting the first sub-layer.

15 The so far explained transmission lines assume the dimension in the width direction of the ground plane constituted by the conductive housing component 2 to be infinite with its flat surface on top of which the dielectric layer 4 and the conductor 3 are attached. However, it might be desired to provide projections projecting from the same surface of the conductive
20 housing component 2 besides the arrangement of the dielectric layer 4 and the conductor 3.

Examples for such projections are shown in two different versions in figure 6. The left side of the arrangement of the dielectric layer 4 in the conductor 3 shows a projection 6 that may typically be formed when the conductive housing component 2 is made by extruding a metal, for
25 example, aluminium for forming a metallic housing of a luminaire. On the right side in figure 6 an alternative version is illustrated, typically formed in case that a metallic housing of the luminaire is made by forming or deep drawing a metal sheet. The resulting projection 6' results in the same electrical characteristics of the transmission line as the projection 6, assumed that the distance between the edges of the conductor 3 and the respective projection 6, 6' is the same.
30 Distance and height of such projection 6, 6' may be adjusted depending on the desired electrical characteristics of the resulting transmission line 1. Further, it is to be noted that the height of the projections is also not limited to be substantially equal to the overall height of the arrangement of the dielectric layer 4 and the conductor 3 but can also be adjusted according to the specific requirements. In particular, the projections may be formed by an adjacent wall of
35 the housing of the luminaire.

Although figure 6 illustrates the projections 6, 6' in combination with the simple form of a transmission line 1, it is evident that such projections 6, 6' may also be provided in combination

with any of the other above explained embodiments of transmission lines illustrated in figures 3 to 5.

Figure 7 schematically shows a cross-section of a lighting rail as an example of a housing for a luminaire. Such lighting track is known in the art and the plurality of such lighting tracks can be connected to each other in order to reach lengths of up to 100 m, for example. Such lengths are reached by connecting a plurality of modules (housings), whereby the connection of the modules does not necessarily connect the modules in only one dimension. Rather, various geometries of the connected modules can be used to generate different grid shapes, depending on circumstances in the building.

Preferred positions at which a transmission line according to one of the above-mentioned embodiments explained with reference to any of figures 1 to 6 can be attached are indicated by characters "A", "B", "C" or "D". It is preferred to arrange the transmission line on an inside of the housing as indicated by A or D in case that the dielectric layer 4 and the conductor 3 are attached to the conductive housing component 2 during manufacturing of the luminaire. While the corrugation at position B and also the flat outer surface at position C may be used in the manufacturing process, it is evident that these positions are easily accessible even at a construction site after mounting the housing to generate a lighting structure in the building.

Attaching the dielectric layer 4 and the conductor 3 (or, of course, the plurality of dielectric layers and conductors as explained above with reference to the figures 1 to 6) at the construction site has the advantage that a plurality of conductive housing components 2 may be mounted first to generate a modular housing and, then, the transmission line is generated by attaching the dielectric layer 4 and the conductor 3 extending over a plurality of connected conductive housing components 2.

In case that the arrangement of the conductive layer 4 and the conductor 3 is already applied in the manufacturing process, a connector is used in order to connect successive transmission lines established on individual modules.

Figure 7 also illustrates a further embodiment of the line according to the present invention, which is built as a 3D-line with parts of the conductive housing component 2, indicated portion 8 at least partially surrounding a dielectric layer 9 enclosing a conductor 7. Since the sequence of the ground plane established by the conductive housing component 2 (including the projecting and surrounding portion 8), the dielectric layer 9 and the conductor 7 is still the same, it is evident that even in case of the 3D-line the conductor 7 and the conductive housing component 2 "sandwich" the dielectric layer 9.

It is to be noted that in the preferred and illustrated embodiment the dielectric layer 9 entirely encloses the conductor 7. However, for easier manufacturing the intermediates dielectric layer 9 may also only partially surround the conductor 7. The resulting structure resembles a coaxial line and provides comparable electrical characteristics.

5

Additionally or alternatively, the dielectric layer 9 may enclose the conductor 7 not along the full length of the conductor 7, but only in certain intervals in order to reduce losses. This may also achieve an improved transmission of signals at certain frequencies or frequency bands. This embodiment approximates, for example, dielectric layers formed like rings along the conductor

10 7.

It is also possible that, similar to the embodiments explained above, an adhesive tape is used as the dielectric layer 9 with the conductor 7 attached to the adhesive tape. The adhesive tape is then applied to the inside of a cavity created by the portion 8 of the conductive housing

15

component 2. Similar to the explanations given above with reference to figure 6, such portions 8 of the conductive housing component 2 may positively influence the electrical characteristics of the resulting line for transmitting communication signals in the housing of the luminaire.

The luminaire using the conductive housing component 2 comprises one or more electronic components, not shown in the figures. The electronic components may serve different purposes in the luminaire or a lighting system. Apparently, the electronic component may be used for controlling an light source of the luminaire. For transmitting or receiving communication signals, the electronic component contacts the conductor 3 so that the transmission line 1 is used for transmitting and receiving communication signals. The transmission of communication signals may be performed between a plurality of electronic components of the same luminaire but also between electronic components arranged in different parts for different luminaires.

20

25

An electronic component may also be a transceiver coupled to the transmission line according to the invention and capable of transmitting and receiving signals via different communication channels, for example, wirelessly with remote further electronic components. The transmission lines 1, 1', ... as illustrated and explained above are preferably used to establish a bus system within a lighting arrangement such as a light track.

30

For contacting the conductor 3, 3a, 3b established techniques may be used like an elastic metal contact (spring contact), a conductive glue, or a mechanical solution like a spring arrangement pressing a contacting pin on the surface of the conductor 3, 3a, 3b. Figures 8 and 9 illustrate techniques for contacting the conductor 3, 3a, 3b. Those techniques are generally known in the art. Using these contacting elements in combination with the transmission line 1 enables

35

connecting signal sources (transmitter) and signal sinks (receiver) for the high frequency signal transmitted over the transmission line 1 to the conductor 3, 3a, 3b of the transmission line 1.

Alternatively or additionally, the contacting elements may connect the conductors 3, 3a, 3b of individual luminaires with each other in order to achieve transmission of high frequency signals over increased distances and a plurality of luminaires.

Figure 8 illustrates a technique for contacting a transmission line using a spring loaded metal pin 10 as the contacting element. Such spring loaded metal pin 10 is sometimes referenced as pogo pin™.

Figure 9 illustrates an alternative technique for contacting a transmission line using a metal spring 11.1 arranged in a contacting assembly 10 as an alternate embodiment of a contacting element.

With the conductors 3, 3a, 3b, 7 shown in Figures 1 to 9, electrical signals are transmitted from a first electronic component (first contacting element) to a second electronic component (second contacting element), wherein the conductor 3, 3a, 3b, 7 is a part of the transmission line formed by the dielectric layer 4, 4a, 4b, 9, the conductor 3, 3a, 3b, 7 and the ground plane of the conductive housing component 2.

Alternatively or in addition, one or a plurality of conductors 3, 3a, 3b, 7 arranged on the conductive housing component 2 via the dielectric layer 4, 4a, 4b, 9 as shown in Figures 1 to 9 can be an antenna element of an antenna, with which signals can be transmitted and/or received.

Alternatively or in addition, at least one conductor 3, 3a, 3b, 7 arranged on the conductive housing component 2 via the dielectric layer 4, 4a, 4b, 9 as shown in Figures 1 to 9 can be an antenna element. The antenna comprising the antenna element(s) is placed inside or outside the housing and is configured to transmit and/or receive signals.

The antenna can be a monopole antenna, a dipole antenna or a patch antenna, wherein the conductive housing component 2 serves as the ground plane of the antenna and the one or more conductors 3, 3a, 3b, 7 are arranged linear, rectangular, circular and/or triangular on the dielectric layer 4, 4a, 4b, 9.

The conductors 3, 3a, 3b, 7 of the antenna can be connected to an electronic component or a connection cable by the contacting element shown in Figure 8 or 9. Alternatively, the antenna

can be (seamlessly) connected to a transmission line formed by the conductors 3, 3a, 3b, 7, whereas the transmission line is connected to the electronic component.

Figure 10 shows a perspective illustration of a dipole antenna in the form of an adhesive pad
5 attachable to the inside or outside of the conductive housing component 2. The pad is formed of a flexible material and comprises the dielectric layer 4, which is a single-sided adhesive tape, and two conductors 3a, 3b fixed on the dielectric layer 4. Each conductor 3a, 3b comprises an electrical contact 12a, 12b formed at its free end and one of the two antenna elements 13a, 13b formed at its other end. The electrical contacts 12a, 12b provide an increased contact surface for
10 the contacting elements. The part of the pad including the electrical contacts 12a, 12b can be inserted into the housing, whereas the part including the two antenna elements 13a, 13b can be attached to the outside of the housing.

After the dipole antenna shown in Figure 10 is attached to the conductive housing component 2,
15 the housing inclusive of the antenna can be coated (powder coating, spray painting, or anodizing) to produce uniform colouring and/or to provide a further dielectric layer on the top of the two conductors 3a, 3b that are arranged on the dielectric layer 4.

Figure 10 shows a cross-section of a transmission line formed as a coplanar-backed waveguide using the conductive housing component 2. The transmission line consists of a first conductor
20 3a arranged on the dielectric layer 4, together with a pair of return conductors 3b, 3c, one to either side of the first conductor 3a, and the conductive housing component 2 serving as a third return conductor. All three conductors 3a..3c are on the same side of the dielectric layer 4, and hence are coplanar, wherein the conductive housing component 2 covers the entire back-face of the dielectric layer 4. The return conductors 3b, 3c are separated from the central first
25 conductor 3a by a respective gap 14a, 14b, which has an unvarying width along the length of the transmission line.

The housing or the conductive housing component 2 shown in figures 1 to 9 and 11 is a housing/
housing component of a luminaire. Alternatively, the housing can be a housing of an operating
device for an illuminant (e.g. a LED driver or a ballast for fluorescent lamps), a LED module or a
30 sensor device.

Claims

1. Housing for a luminaire or an operating device for the luminaire, the housing being configured to accommodate at least one electronic component and/or a light source, and
5 comprising a conductive housing component (2),
characterized in that
the housing includes at least one line (1, 1', 1'', 1''', 1''''') for transmitting electric high frequency signals or for transmitting and/or receiving radio waves, wherein at least one line (1, 1', 1'', 1''', 1''''') is formed by arranging a dielectric layer (4, 4a, 4b, 9) and a conductor (3, 3a..3c, 7) on the
10 housing component (2) such that the conductive housing component (2) serves as a ground plane, and the conductive housing component (2) and the conductor (3, 3a..3c, 7) sandwich the dielectric layer (4, 4a, 4b, 9).
2. Housing according to claim 1
15 characterized in that
the dielectric layer (4, 4a, 4b, 9) is at least partially established by a coating material.
3. Housing according to claim 1 or 2
characterized in that
20 the dielectric layer (4, 4a, 4b, 9) is at least partially applied in form of an adhesive tape stucked to the housing component (2).
4. Housing according to claim 3
characterized in that
25 the adhesive tape carries the conductor (3, 3..3c, 7) or the conductor (3, 3..3c, 7) comprises an adhesive coating.
5. Housing according to any one of claims 1 to 3,
characterized in that
30 the conductor (3, 3..3c, 7) is applied by metal deposition, drawing conductive ink or attaching a metal foil.
6. Housing according to any one of claims 1 to 5,
characterized in that
35 the dielectric layer (4, 4a, 4b, 9) and another dielectric layer sandwich the conductor (3, 3a, 3b, 7) so that the conductor (3, 3a, 3b, 7) is completely enclosed by the dielectric layer (4, 4a, 4b, 9) and the other dielectric layer.

7. Housing according to any one of claims 1 to 6,
characterized in that

the housing component (2) comprises a flat section to which the dielectric layer (4, 4a, 4b) and
the conductor (3, 3..3c, 7) are attached so as to establish a transmission line and/or an antenna,
5 in particular a microstrip and a microstrip patch antenna, respectively.

8. Housing according to claim 7,
characterized in that

the antenna is a monopole antenna or a dipole antenna (13a, 13b).

10

9. Housing according to claims 7 or 8,
characterized in that

the transmission line is connected to the antenna.

15 10. Housing according to any one of claims 7 to 9,
characterized in that

the transmission line forms a coplanar waveguide, in which the conductor (3, 3a..3c, 7) together
with a pair of return conductors (3, 3a..3c, 7) sandwiching the conductor (3, 3a..3c, 7) are
arranged on the same side of the dielectric layer (4, 4a, 4b, 9) and the conductive housing
20 component (2) serves a third return conductor.

11. Housing according to any one of claims 7 to 10,
characterized in that

a plurality of transmission lines is arranged stacked, twisted or side by side.

25

12. Housing according to any one of claims 7 to 11,
characterized in that

a projection (6, 6') is formed on the housing component (2) projecting from the flat section from
the same surface to which the dielectric layer (4, 4a, 4b) and the conductor (3, 3..3c b, 7) are
30 attached.

13. Housing according to any one of claims 1 to 12,
characterized in that

the line is (1''') as a 3D-line with a part of the housing surrounding the conductor (3, 3..3c, 7) at
35 least partially in cross section.

14. Housing according to any one of claims 1 to 13,
characterized in that

at least one connector is provided contacting the line (1, 1', 1'', 1''', 1''''') and enabling another line (1, 1', 1'', 1''', 1''''') and/or electronic component to connect to the line (1, 1', 1'', 1''', 1''''') for feeding
5 the line (1, 1', 1'', 1''', 1''''') with a signal and/or receiving a signal from the line (1, 1', 1'', 1''', 1''''').

15. Housing according to any one of claims 1 to 14,
characterized in that

the housing comprises a plurality of housing components (2) commonly forming a ground plane
10 of the line (1, 1', 1'', 1''', 1''''') established by commonly arranging a dielectric layer (4, 4a, 4b, 9)
and a conductor (3, 3..3c, 7) on the housing components (2).

16. Housing according to any one of claims 1 to 14,
characterized in that

15 the housing comprises a plurality of housing components (2) each forming a ground plane of
respective line (1, 1', 1'', 1''', 1''''') sections wherein the line (1, 1', 1'', 1''', 1''''') sections of the
plurality of housing components (2) are connected to realize line (1, 1', 1'', 1''', 1''''').

17. Luminaire comprising a housing according to any one of claims 1 to 16 and further
20 comprising at least one electronic component contacting the line (1, 1', 1'', 1''', 1''''') for
transmitting and/or receiving a signal.

18. Luminaire according to claim 17,
characterized in that

25 ground of the electronic component is connected to the metallic housing component (2).

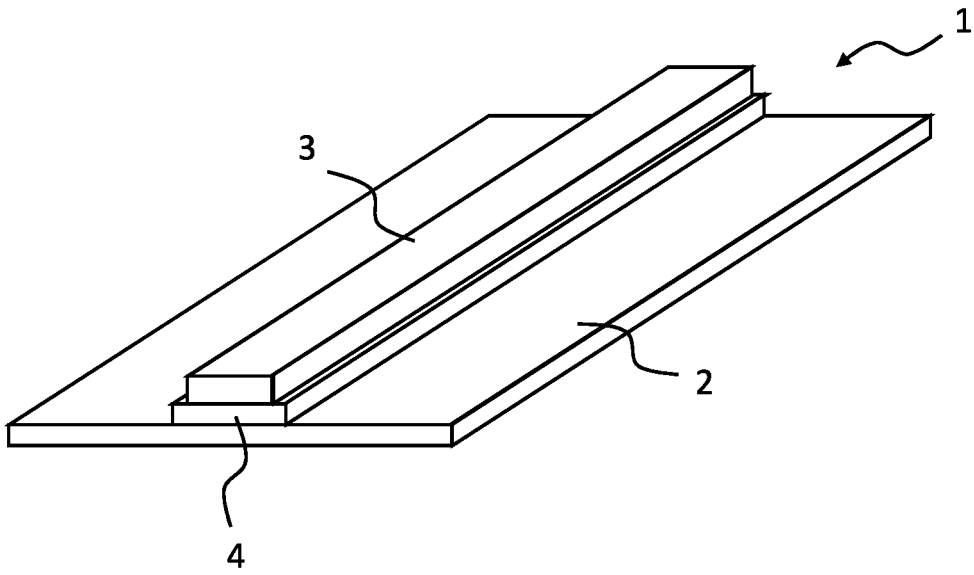


Fig. 1

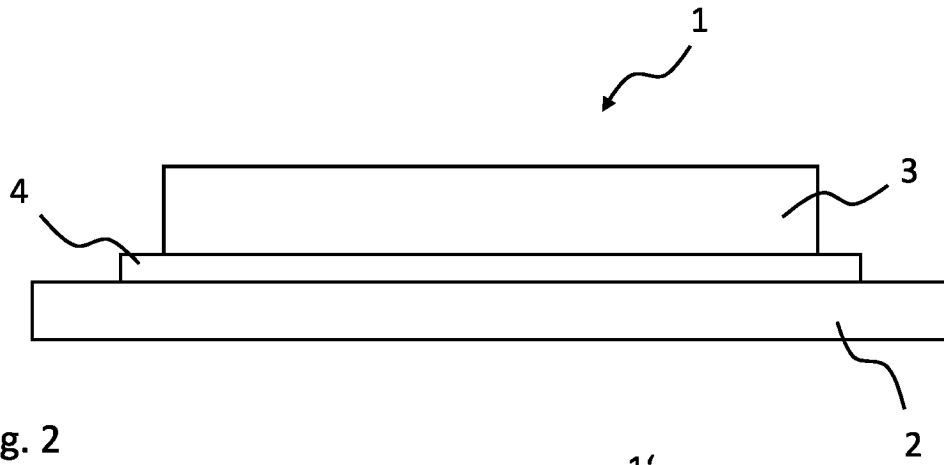


Fig. 2

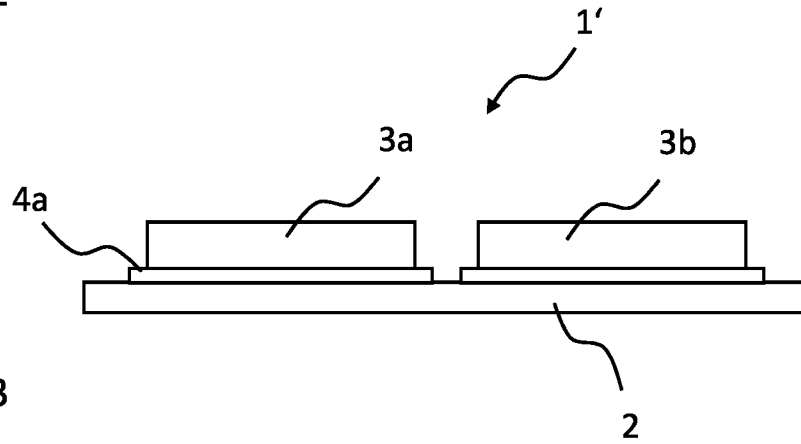


Fig. 3

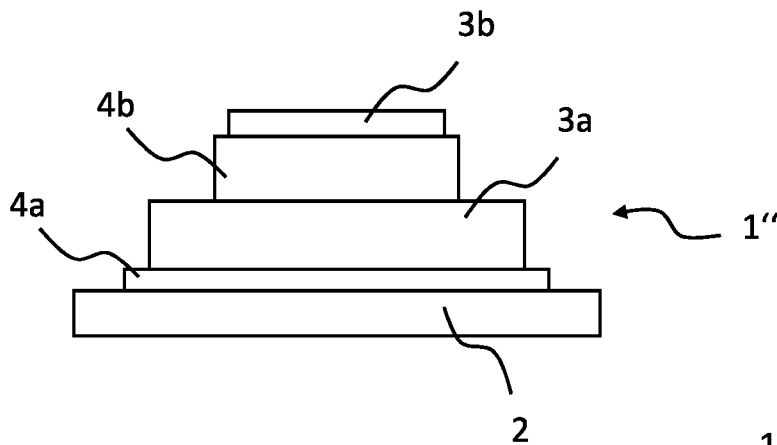


Fig. 4

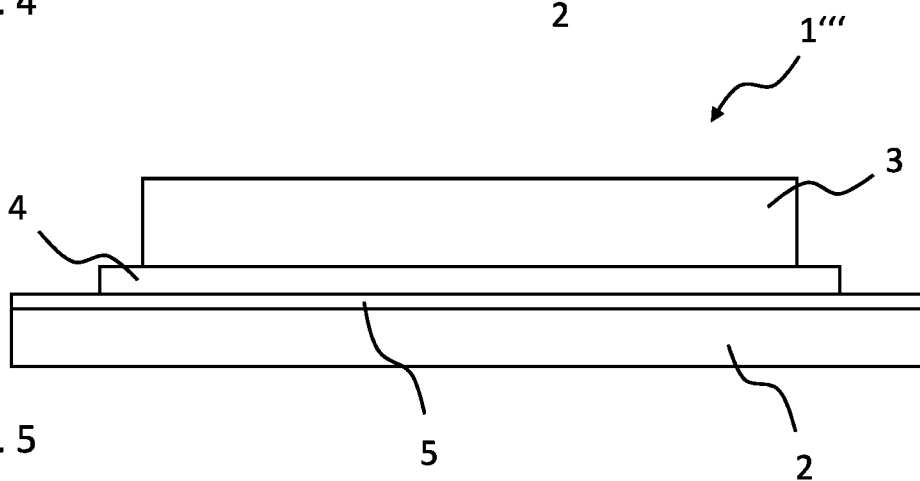


Fig. 5

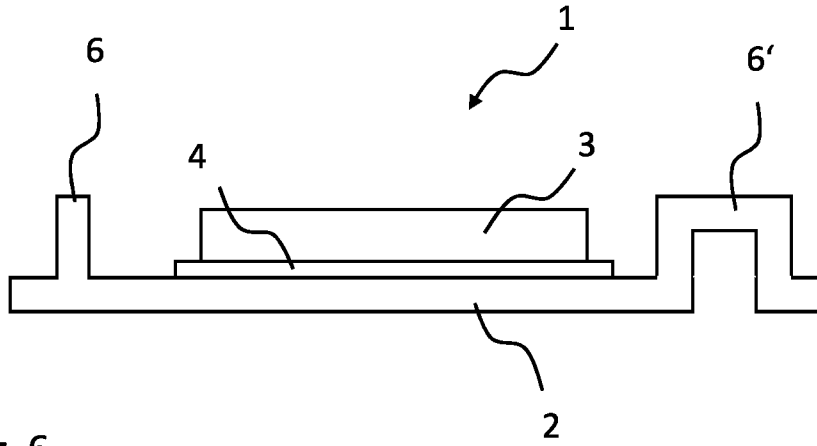


Fig. 6

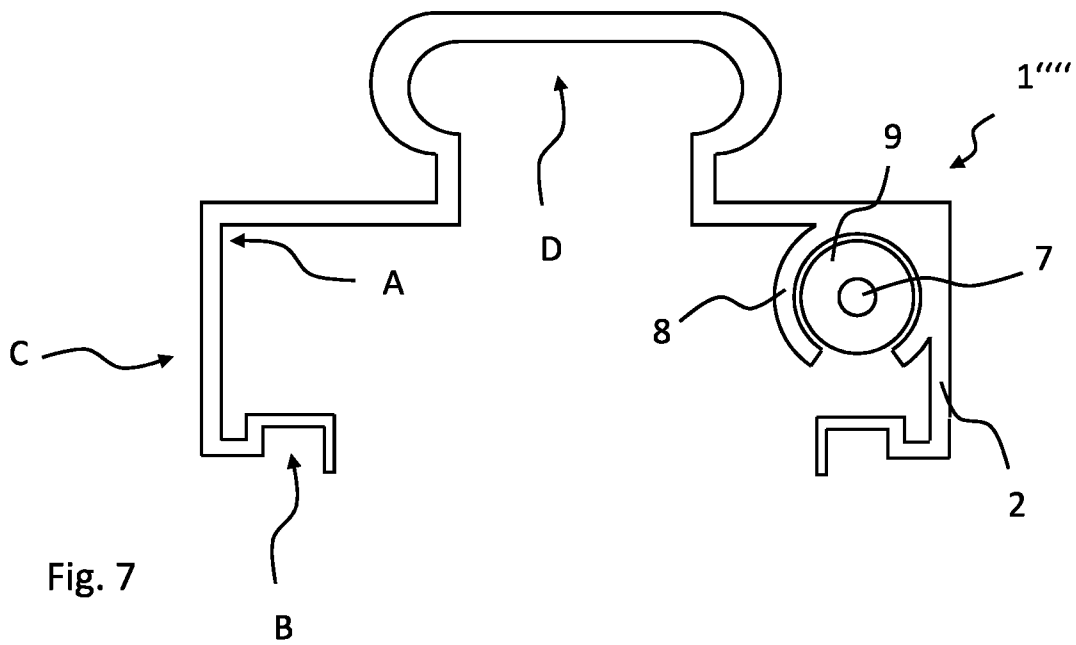


Fig. 7

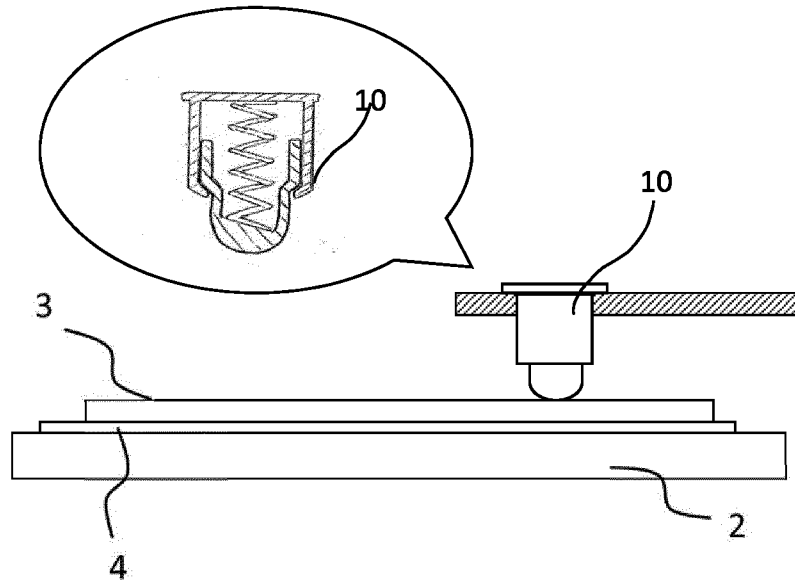


Fig. 8

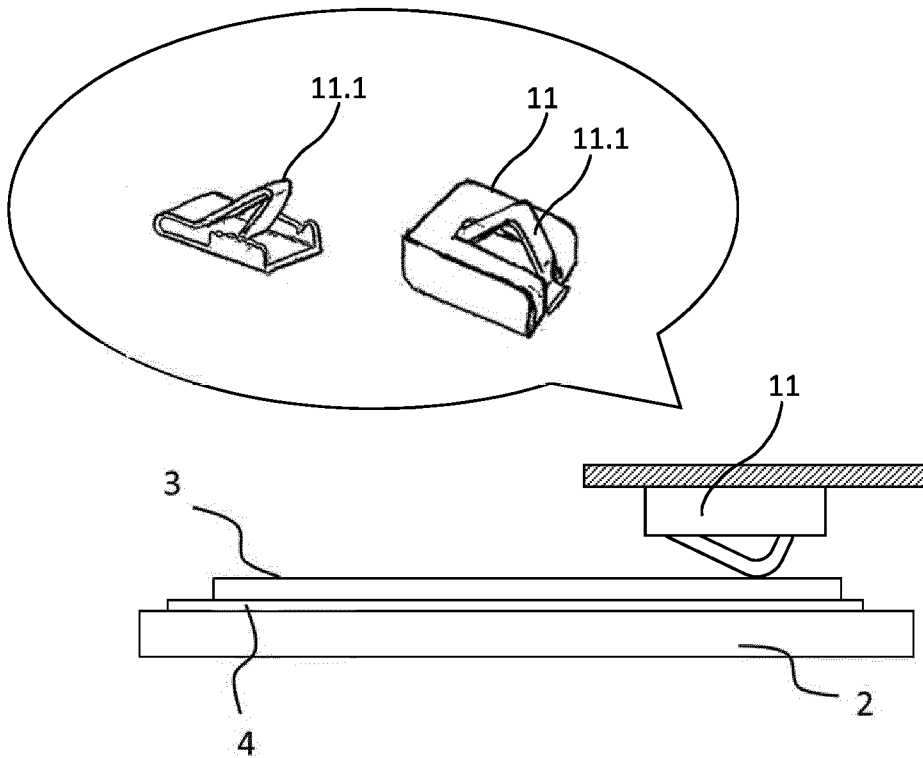


Fig. 9

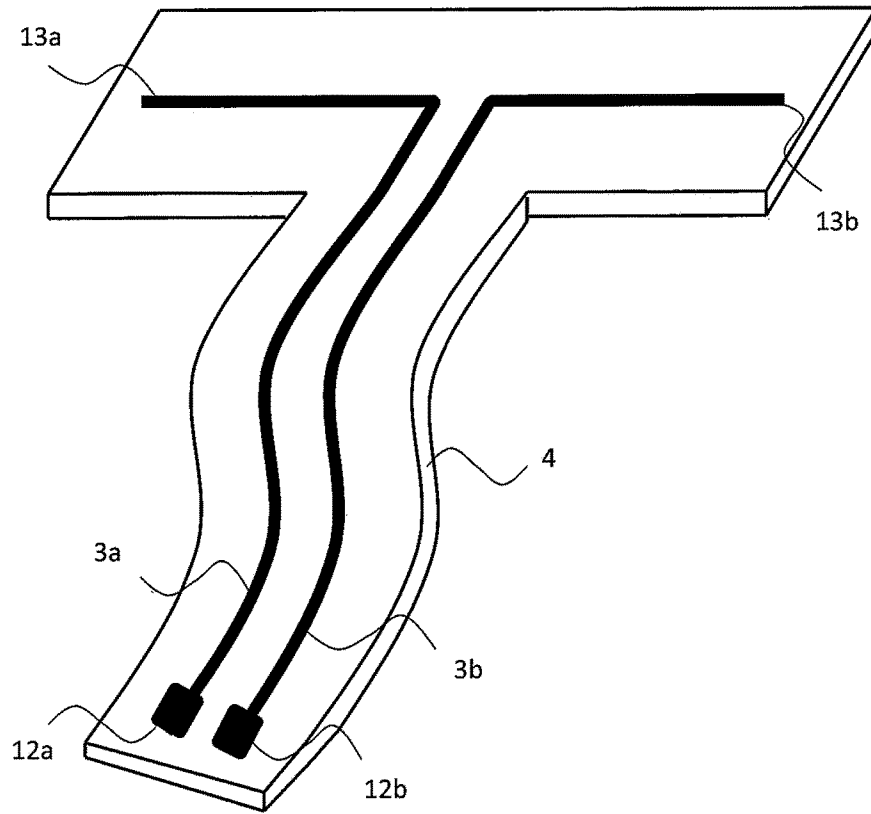


Fig. 10

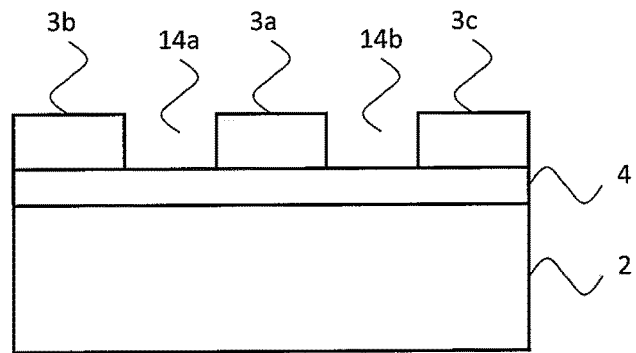


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/071594

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H05K1/05
 ADD. H05K1/02 F21V15/01 F21V23/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 H05K F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2016/123569 A1 (CUMMINGS WILLIAM J [US]) 5 May 2016 (2016-05-05) claim 1 paragraphs [0044], [0067], [0068], [0075], [0077] figures 2,7,9	1-7, 11-18
Y	US 6 384 345 B1 (AKIHA YOSHINOBU [JP]) 7 May 2002 (2002-05-07) column 1, lines 6-8,13-19,58 column 5, lines 22-25 figures 1,2	1-7, 11-18
X	JP 2019 149308 A (PANASONIC IP MAN CORP) 5 September 2019 (2019-09-05)	1,7-9
Y	paragraphs [0065] - [0066], [0077], [0078]	10,18
	----- -/--	

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search 3 November 2021	Date of mailing of the international search report 11/11/2021
--	--

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Dardel, Blaise
--	--

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/071594

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6 144 268 A (MATSUI NORIFUMI [JP] ET AL) 7 November 2000 (2000-11-07) figures 3,5 column 6, lines 1-3 -----	6
Y	DE 10 2018 203508 A1 (OSRAM GMBH [DE]) 12 September 2019 (2019-09-12) paragraph [0050] claim 1 -----	10
A	US 2019/312346 A1 (WANG QIANG [CN] ET AL) 10 October 2019 (2019-10-10) figure 9 -----	1-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2021/071594

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016123569	A1	05-05-2016	US 2016123569 A1
			WO 2014197782 A1

US 6384345	B1	07-05-2002	DE 10050629 A1
			GB 2358965 A
			JP 3852899 B2
			JP 2001111259 A
			US 6384345 B1

JP 2019149308	A	05-09-2019	NONE

US 6144268	A	07-11-2000	CA 2249489 A1
			CN 1214556 A
			DE 69828249 T2
			EP 0917236 A2
			JP H11177310 A
			KR 19990036977 A
			NO 317564 B1
			US 6144268 A

DE 102018203508	A1	12-09-2019	NONE

US 2019312346	A1	10-10-2019	AU 2017379015 A1
			BR 112019012990 A2
			CN 108242587 A
			EP 3550666 A1
			JP 2020502947 A
			KR 20190091361 A
			US 2019312346 A1
			WO 2018113679 A1
